National Aeronautics and Space Administration

Space Travel

CFD Support for Launch Environment Flame Trench Analysis

NASA Advanced Supercomputing (NAS) Division modeling and simulation experts are supporting ground operations at NASA Kennedy Space Center (KSC) by conducting time-accurate simulations of the launch pad and Space Shuttle configuration during ignition.

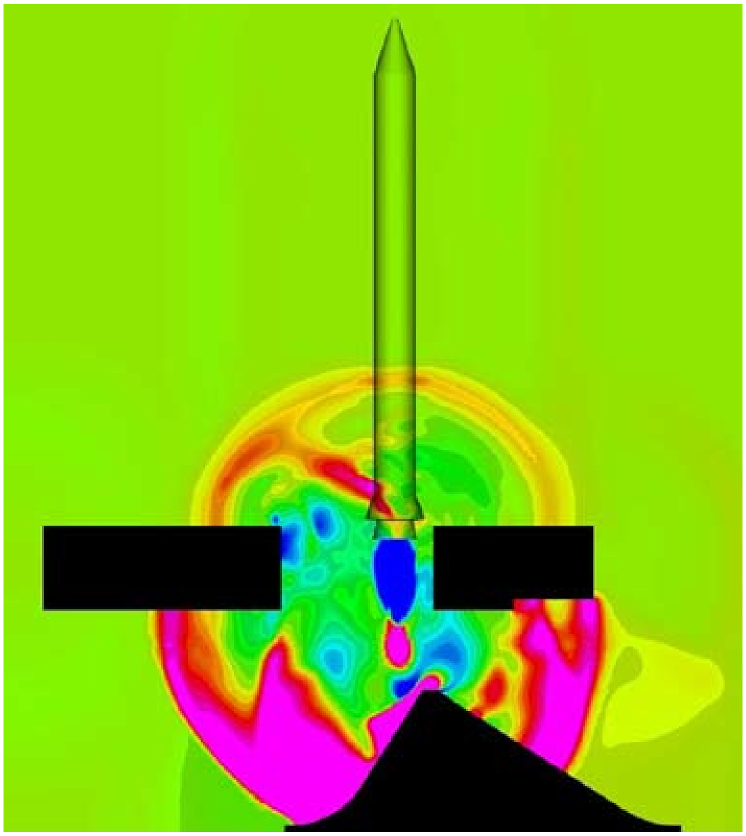
Using the NASA-developed OVERFLOW code, along with other computational fluid dynamics (CFD) codes, NAS is analyzing the effects of ignition exhaust plumes on the flame trench below the vehicle. NAS CFD experts have developed a modeling framework for launch pad applications, in which they can generate simulations and validate them with measured flight data collected during earlier shuttle missions.

Recently, these simulations have been used to help determine whether the existing trench and deflector system used to launch shuttles can withstand flow from NASA's next-generation Ares launch vehicles. These predictions of ignition overpressure (IOP) in a launch environment will contribute to safer missions.

Time-accurate simulations of the flame trench have been performed to identify the root cause of damage to its wall sustained during the launch of shuttle mission STS-124. The computed pressure data were compared with data from a previous flight (STS-4) and good correlation was observed. The resulting loads on the damaged wall were provided to KSC to assist in the critical repair effort.

Recently, an extensive time sensitivity analysis was performed in order to optimize the computational resources required to complete a full three-dimensional IOP simulation. The time-accurate pressure histories at various locations in the two-dimensional flame trench model were monitored to investigate the sensitivity of IOP propagation to varying time-step and subiteration parameters chosen in the dual-time stepping method. Results of this analysis were used to determine the minimum computational requirements necessary to accurately predict IOP wave phenomenon in the flame trench.

Time-accurate simulations of large computational domains are only possible with NASA's extensive supercomputing resources to run many calculations (512 processors per case) over many months.



Pressure contours on a cutting plane through a Solid Rocket Booster and along the flame trench in a time-dependent simulation of ignition overpressure.

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